WE CLAIM:

1. A heat treatment apparatus for successively heat treating a series of planar substrates one by one in a plurality of heat treatment cycles, the apparatus comprising:

a furnace body having a boundary surface oriented to face one of the series of substrates upon positioning of the substrate in the heat treatment apparatus for heat treatment;

a controllable heater configured to heat the furnace body at a power level set by a power setting;

a heat treatment temperature sensor configured to measure a treatment temperature experienced by the substrate during heat treatment; and

a temperature regulator for controlling the treatment temperature, the temperature regulator configured to receive a heat treatment temperature reading from the treatment temperature sensor, to receive a desired temperature input for a desired treatment temperature and to generate and to output the power setting for the heater, wherein the temperature regulator further comprises:

a first computational component configured to generate one or more trigger signals resonant with a frequency of the heat treatment cycles; and

a second computational component configured to calculate a control set-point, the control set-point at least partially determining the power setting for the heater, the second computational component further configured to receive the trigger signals and to calculate, upon receiving the trigger signals, a new control set-point using the treatment temperature readings and to hold the new control set-point until the calculation is triggered again by a next trigger signal.

2. The heat treatment apparatus of Claim 1, wherein the first computational component comprises a logistics controller configured to provide a trigger signal indicating a loading of one of the series of substrates into the apparatus for heat treatment.

3. The heat treatment apparatus of Claim 1, wherein the first computational component is configured to receive treatment temperature readings from the heat treatment temperature sensor and to generate during each treatment cycle one or more trigger signals based on the treatment temperature readings.

4. The heat treatment apparatus of Claim 3, wherein the first computational component is configured to generate a trigger signal when a desired treatment temperature is reached.

5. The heat treatment apparatus of Claim 4, further comprising a logistics controller, the logistics controller configured to receive the trigger signal corresponding to receiving the desired treatment temperature and loading a next substrate upon receiving the trigger signal.

6. The heat treatment apparatus of Claim 3, wherein the first computational component is configured to generate a trigger signal when a treatment temperature minimum within a treatment cycle is reached.

7. The heat treatment apparatus of Claim 1, wherein the control set-point is the power setting.

8. The heat treatment apparatus of Claim 1, wherein the furnace body has a plurality of heating zones.

9. The heat treatment apparatus of Claim 8, wherein each of the plurality of heating zones has an independently controlled heater.

10. The heat treatment apparatus of Claim 1, wherein the heat treatment temperature sensor is inside the furnace body and proximate the boundary surface.

11. The heat treatment apparatus of Claim 1, further comprising:

a heater side temperature sensor configured to measure a heater side temperature at a part of the furnace body proximate the heater; and

wherein the control set-point is a target heater side temperature and wherein the temperature regulator for controlling the treatment temperature comprises:

a boundary surface temperature regulator constituting part of the second computational component, the boundary surface temperature regulator configured to receive the desired temperature input and the reading from the heat treatment temperature sensor and to calculate and to output the control set-point; and

a heater side temperature regulator configured to receive a temperature reading from the heater side temperature sensor and to receive the control set-point, wherein the heater side

temperature regulator is further configured to regulate the heater side temperature at the control set-point value by generating and outputting the power setting for the heater.

12. The heat treatment apparatus of Claim 11, wherein the boundary surface temperature regulator and the heater side temperature regulator are separate pieces of hardware.

13. The heat treatment apparatus of Claim 11, wherein the heater side temperature regulator is configured to adjust the power level of the heater about once every second or less to maintain the heater side temperature at the control set-point value.

14. The heat treatment apparatus of Claim 12, wherein the boundary surface temperature regulator and the heater side temperature regulator are each chosen from the group consisting of PID controllers, H∞ controllers, and model-based controllers.

15. The heat treatment apparatus of Claim 12, wherein the boundary surface temperature regulator and the heater side temperature regulator are included in a single piece of hardware.

16. The heat treatment apparatus of Claim 1, further comprising:

a time window filter configured to output one or more filtered treatment temperature readings that are measured by the treatment temperature sensor within a time window and to block treatment temperature readings that are outside the time window,

wherein the treatment temperature readings used to calculate the new control set-point are the one or more filtered temperature readings.

17. The heat treatment apparatus of Claim 16, wherein the time window filter is configured to output filtered treatment temperature readings from about a moment of the positioning of the substrate in the heat treatment apparatus for heat treatment.

18. The heat treatment apparatus of Claim 17, wherein the filtered treatment temperature readings comprise only temperature readings from about 0.1 to 3 seconds before the moment of the positioning of the substrate.

19. The heat treatment apparatus of Claim 1, further comprising:

a throughput controller connected to the temperature regulator, the throughput controller configured to receive a desired throughput input indicating a desired heat treatment throughput of substrates for the heat treatment apparatus and to receive an input indicating an

actual throughput of substrates for the heat treatment apparatus and to output a throughput control signal to the second computational component based on the inputs,

wherein the second computational component is configured to calculate the new control set-point based at least partially upon the throughput control signal.

20. The heat treatment apparatus of Claim 19, wherein the throughput controller is a P controller.

21. The heat treatment apparatus of Claim 19, wherein the throughput controller and the temperature regulator are included in a single piece of hardware.

22. A semiconductor processing reactor for individually treating a series of substrates, comprising:

a boundary surface for facing one of the series of substrates during heat treatment, the boundary surface comprising a plurality of heating zones;

a plurality of temperature sensors proximate the boundary surface, the plurality of temperature sensors configured to measure a boundary surface temperature of each heating zone;

a plurality of independently controlled heaters for heating each of the plurality of heating zones to a desired processing temperature, each heater having a control set-point for determining a power level of that heater;

a substrate loading signal generator configured to trigger a loading of one of the series of substrates into the reactor about when one or more of the plurality of heating zones reaches a desired processing temperature; and

one or more temperature controllers for regulating the boundary surface temperature, wherein the one or more temperature controllers is configured to receive the boundary surface temperature readings and to calculate, at a recalculation frequency resonant with a loading frequency of each of the series of substrates, a next control set-point for each heating zone for a next one of the series of substrates.

23. The reactor of Claim 22, further comrpising a temperature reading filter configured to receive and filter the boundary surface temperature readings outside a time window and to output one or more filtered temperature readings encompassed within the time window.

24. The reactor of Claim 22, wherein the one or more temperature controllers have a recalculation frequency of once per loading of each of the series of substrates.

25. The reactor of Claim 22, wherein each heating zone is associated with its own heater, temperature sensor and temperature controller.

26. The reactor of Claim 25, wherein each heating zone is configured to have the same desired temperature reading.

27. The reactor of Claim 22, wherein the temperature reading filter is configured to output an average of the temperatures in the time window as the one or more filtered temperature readings.

28. The reactor of Claim 27, wherein the time window spans a time between the loading of one of the series of substrates and the loading of the next one of the series of substrates for heat treatment.

29. The reactor of Claim 22, further comprising:

a second heated surface opposite the boundary surface, wherein a substrate is accommodated between the second heated surface and the boundary surface during heat treatment.

30. The reactor of Claim 29, configured to suspend the substrate with flowing gas between the second heated surface and the boundary surface without mechanically contacting either the second heated surface or the boundary surface.

31. The reactor of Claim 30, wherein the second heated surface and the boundary surface each comprise a plurality of heating zones.

32. The reactor of Claim 31, wherein a spatial arrangement and number of heating zones in each of the second heated surface and the boundary surface are the same.

33. The reactor of Claim 22, further comprising a throughput controller connected to the one or more temperature controllers, the throughput controller configured to provide an input to the one or more temperature controllers to adjust calculation of the next control set-point depending upon a desired throughput and an actual throughput of the reator.

34. An apparatus for semiconductor processing, the apparatus configured to process a plurality of substrates one by one, the apparatus comprising:

a heating body having a surface delimiting a substrate processing position;

a controllable heater for heating the heating body, wherein the heater is proximate the heating body and has a control set-point controlling a heater temperature;

a heat treatment temperature sensor configured to trigger a loading of one of the series of substrates when a temperature at the substrate processing position reaches a desired temperature;

a timer configured to determine an instantaneous actual throughput of the apparatus; and

a temperature regulator for controlling the processing temperature, the temperature regulator configured to receive a throughput input indicating a desired processing throughput and to calculate and to output, after the loading of the one of the series of substrates is triggered, a new control set-point to the heater based at least partially upon the throughput input and the instantaneous actual throughput.

35. The apparatus of Claim 34, wherein the temperature regulator is configured to calculate the new control set-point immediately after the loading of one of the series of substrates is triggered, wherein the new control set-point is calculated based at least partially upon the instantaneous actual throughput.

36. The apparatus of Claim 34, wherein the control set-point is a desired temperature for a part of the heating body proximate the heater and wherein the apparatus further comprises:

a second temperature sensor proximate the heater and configured to measure a temperature of a part of the heating body proximate the heater; and

wherein the temperature regulator comprises a heater side temperature regulator connected to the heater and the second temperature sensor, the heater side temperature regulator configured to continuously adjust the heater temperature to maintain the part of the heating body proximate the heater at about the control set-point value.

37. The apparatus of Claim 36, wherein the heater side temperature regulator is configured to adjust the heater temperature about once every second or less.

38. The reactor of Claim 34, wherein the temperature regulator is configured to receive temperature readings from the heat treatment temperature sensor and to calculate and output a new control set-point based upon a temperature reading at about or immediately

before the loading of one of the series of substrates to maintain the temperature at the substrate processing position at the desired temperature.

39. The reactor of Claim 34, wherein the heating treatment temperature sensor is located inside the heating body and less than about 5 mm away from the surface.

40. The reactor of Claim 39, wherein the heating treatment temperature sensor is located less than about 2 mm away from the boundary surface.

41. A method for individually processing a series of semiconductor substrates, comprising:

providing a reactor having a process chamber, the chamber having a process temperature, wherein the reactor has a heater for heating the chamber to a desired process temperature, wherein the heater has a control set-point for determining a power level of the heater;

successively loading each of the series of substrates into the chamber and then unloading each of the series of substrates out of the chamber, wherein loading a substrate into the chamber reduces the process temperature, wherein the heater set at the control set-point heats the chamber back up to the desired process temperature after loading the substrate reduces the process temperature, wherein loading is performed about when the chamber is at the desired process temperature and unloading is performed before the substrate reaches the desired process temperature again;

monitoring the chamber for a calculation condition, wherein meeting the calculation condition triggers a calculation of a new control set-point based upon one or more process temperature readings; and

calculating the new control set-point, wherein calculating is performed at a frequency resonant with a substrate loading or unloading frequency, wherein the control set-point is held until the calculation condition is met again.

42. The method of Claim 41, wherein the calculation of the control set-point is based upon one or more process temperature readings before or during about when the calculation condition is met.

43. The method of Claim 41, wherein calculating is performed at least once between loading of successive substrates.

44. The method of Claim 41, wherein the calculation condition is met by a loading or an unloading of a substrate.

45. The method of Claim 41, wherein the calculation condition is met when a process temperature of the chamber is at a minimum or a maximum temperature between loading of successive substrates.

46. The method of Claim 41, wherein the calculation condition is met when a flow of gas through the chamber is altered.

47. The method of Claim 41, wherein the heater is configured to heat a heating body, thereby heating the chamber to the desired process temperature.

48. The method of Claim 47, wherein the heating body comprises a plurality of heating zones, wherein each heating zone is heated by a different heater to a different desired temperature.

49. The method of Claim 47, wherein the control set-point is a desired temperature of a part of the heating body proximate the heater.

50. The method of Claim 49, wherein the heater is connected to a first temperature controller configured to analyze a temperature of the part of the heating body proximate the heater and to adjust the power level of the heater to maintain the temperature at the desired temperature of the part of the heating body proximate the heater.

51. The method of Claim 50, wherein the power level of the heater is adjusted about once per second.

52. The method of Claim 41, wherein the control set-point is the setting of the power level.

53. The method of Claim 41, wherein calculating the new control set-point comprises filtering all process temperature readings to arrive at process temperature readings in a period immediately before the second substrate reduces the process temperature.

54. The method of Claim 53, wherein the period spans about 1 to about 10 measured temperature values.

55. A method for heat treating a series of semiconductor substrates one by one, comprising:

providing a reactor having a heat treatment position for heat treating each of the series of substrates, wherein the reactor has a throughput input indicating a desired heat treatment throughput of substrates and a treatment temperature input indicating a desired treatment temperature and wherein the reactor has a heater with a control set-point for establishing the desired treatment temperature at the heat treatment position;

successively positioning each of the series of substrates at and removing each of the series of substrates from the heat treatment position, wherein a time from loading one substrate to a next substrate constitutes a substrate cycle;

measuring the treatment temperature as a function of time; and

calculating and applying only one new control set-point during each substrate cycle, wherein the new control set-point is determined at least partially based upon the desired treatment temperature, the measured treatment temperature, and the desired heat treatment throughput for the series of substrates.

56. The method of Claim 55, wherein successively positioning each substrate is performed when the heat treatment position is at about the desired treatment temperature, wherein positioning each substrate reduces a temperature at the heat treatment position and removing is performed before the heat treatment position recovers to the desired temperature,

57. The method of Claim 55, wherein a duration of the substrate cycle determines an actual heat treatment throughput of the reactor.

58. The method of Claim 57, wherein the new control set-point is determined at least partially based upon the actual heat treatment throughput

59. The method of Claim 55, wherein measuring is performed at least once per substrate cycle and at about the same time, relative to each successive positioning, during each substrate cycle.

60. The method of Claim 55, further comprising detecting the positioning of each of the series of substrates at the heat treatment position to trigger calculating a new control set-point.

61. The method of Claim 60, wherein detecting comprises determining when a substrate is at the heat treatment position based upon a reactor logistics controller.

62. The method of Claim 60, wherein detecting comprises actively monitoring the heat treatment position for a presence of a substrate.

63. The method of Claim 62, wherein monitoring the heat treatment position comprises sensing a decrease in furnace body temperature caused by positioning a substrate at the heat treatment position.

64. The method of Claim 55, further comprising suspending each of the substrates at the heat treatment position without mechanically contacting the substrate after successively positioning.

65. The method of Claim 64, wherein reactor comprises a top furnace body and a bottom furnace body between which the substrate is suspended, wherein suspending the substrate comprises flowing gas from the top furnace body and the bottom furnace body to the substrate.

66. The method of Claim 55, wherein successively positioning each of the series of substrates at a heat treatment position comprises positioning each substrate less than about 2 mm from the heating body.

67. The method of Claim 66, wherein successively positioning each of the series of substrates at a heat treatment position comprises positioning each substrate less than about 1 mm from the heating body.

68. The method of Claim 55, further comprising reducing the control set-point after removing a last of the plurality of substrates.

69. The method of Claim 55, wherein the heating element set-point is increased in response to an increase of the desired heat treatment throughput.

70. The method of Claim 55, further comprising performing a profiling procedure before positioning a first of the plurality of substrates, wherein the profiling procedure comprises determining an initial control set-point, the initial control set-point allowing the heated body to be maintained at the desired temperature at steady state, and storing the initial control set-point in a memory.

71. The method of Claim 55, wherein calculating is triggered by positioning of each of the series of substrates at the heat treatment position.